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CONTRIBUTIONS

TO

THE BIOLOGY OF THE PLAICE

WITH SPECIAL REGARD TO THE DANISH PLAICE-FISHERY

VI

ON THE IMMIGRATION OF PLAICE TO THE COASTAL GROUNDS AND FIORDS ON THE WEST COAST OF JUTLAND

BY

A. C. JOHANSEN

KØBENHAVN
I KOMMISSION HOS C. A. REITZEL
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I. INTRODUCTION.

In the Limfiord and in the West Jutland fiords: Nissum Fiord, Ringkøbing Fiord and Hjerting Fiord (the Graadeep inclusive) the plaice does not spawn any more than in the coast-belt off the West coast of Jutland between the coast and a depth of ca. 20 meters. The plaice-fry occurring here is hatched in deeper water in the North Sea and the pelagic larvæ have thus, partly carried by the current, partly through their own movements, arrived near the coast, where they become transformed and live at the bottom, as a rule at small depths, between 0 and 5 meters. This yearly immigration of fry which takes place in spring has been known for a long time, but it is only of later years that we have become acquainted with the fact that the quantity of fry which immigrates in different years differs materially.

Besides this immigration of young fry, an immigration of older fish takes place towards the coast in spring. This spring-immigration comprises both mature fish, which formerly have sought deeper water to spawn, and younger fish. These immigrations, which mainly are looked upon as food-immigrations, take place both in the North Sea, the Kattegat and the Baltic. That has been ascertained through numerous marking and fishing experiments, and seems to be admitted by all writers on the subject.

II. THE IMMIGRATION OF THE PLAICE TO RINGKØBING FIORD AND TO THE OTHER WEST JUTLAND FIORDS.

What rôle the spring immigration of the plaice has played for the West Jutland fiords has been an open question. It was not known if it was only young fry which immigrated into these fiords in spring and early summer, or if older fish took part also in these immigrations to any essential degree.

A contribution to the answer of this question has been obtained during the latest years in Ringkøbing Fiord, where the plaice did not live previously, but which became a feeding ground for plaice after the opening of the Hvide Sande canal on March 3rd. 1910. (Fig. 1.) In the same place a contribution was gained to the understanding of the autumn immigration of the plaice.

Ringkøbing Fiord is situated on the West coast of Jutland between 55° 49′—56° 07′ N. and 8° 08′—8° 24′ E. It has an area of 85 nautical square miles (294 Klm²). It is a very shallow fiord. Its average depth does not come up to more than 1.6 meters and its greatest depth is 5 meters. (Fig. 1 shows the depth lines in the fiord in Danish feet. One Danish foot = 0.314 meters).

Before March 1910 the fiord waters had no opening to the sea but through the long narrow Nyminde Stream and its mouth: Nymindegab.

The salinity of the water was at that time so low that plaice did not occur there. It existed only in the Nyminde Stream and in greater numbers only in the very uttermost part of the stream near to the Nymindegab. The average salinity of the water in the fiord was at that time (in the period from ca. 1845—1910), as far as we can judge from the meagre information to hand, only ca. 4—8 pro mille.

After the opening of the Hvide Sande canal on March 3rd. 1910 the salinity of the water in the fiord changed considerably, and the changes took place at a very rapid rate, as the breadth of the canal during a series of storm periods was very greatly extended. The length of the canal is ca. 1100 meters and its breadth at the water-line was at the time of the opening ca. 26 meters, its depth ca. 2.5 meters, and its water-leading profile ca. 50 m². The increase of the canal may be seen from the table below:

Date	Least breadth meters	Size of the water-leading profile
3. March 1910	26	50 m²
17. — 1910	59	
20. April 1910	70	
Septbr. 1910	80	
March 1911	160	
August 1911	180	
6. Novbr. 1911	230	
February 1912	300	1000 m²
— 1913[1])	ca. 300	1270 m²

From May 26th to October 15th and since November 12th 1911 Nymindegab has been closed, the fiord has thus only been in connection with the sea through the Hvide Sande canal.

The salinity of the fiord water in July 1910 came up to 10—14 ‰ in the Northern and middle parts of the fiord and to 14—17 ‰ in the Skernaa Deep. In July and August 1911 the salinity had for the greater part increased to 26—30 pro mille, and about the same salinity was observed in the fiord in the summer of 1912.

Since the opening of the Hvide Sande canal the author has undertaken for »Kommissionen for Havundersøgelser« a great number of fishing experiments, and these experiments together with a series of observations from practical fishery have, as mentioned before, thrown light upon the spring and autumn immigrations of plaice to the fiord, and in this way probably also to the other West Jutland fiords with the Limfiord.

In the fishing experiments among others was employed the Young Plaice Trawl, a fishing apparatus constructed for the special purpose of catching young flat fishes. This apparatus has in later years been employed every summer and autumn round the coasts of Denmark for comparative captures of young flat fish.

The size of the various parts of the trawl is as follows:

Otter boards	80 × 37 cm
Foot rope	7 Meters
Head line	6 —
Total length	9 —
Width of meshes in belly	1 cm (1 side of mesh)
— - — - cod end	7 mm (1 — - —)

This trawl is drawn from a motor boat with a rapidity of ca. 1 mile per hour.

Fig. 2—4 represent a table of the capture of the different annual series of the plaice in Ringkøbing Fiord in the years 1910, 1911 and 1912.

[1]) For details concerning the Hvide Sande canal I am obliged to the chief engineer of the Water Works Mr. Westergaard. A securing of the canal was commenced in the summer of 1912.

The figures on the charts (Fig. 2—4) indicate the capture calculated per hour for each of the series, the number of individuals of the 0-group coming first, then the number of individuals of I-group and so on.

It will be seen from Fig. 2 that a rather considerable number of plaice of the 0-group occurred in the fiord in the summer of 1910, but proportionately few older specimens. This shows quite plainly that the spring immigration of older specimens only has been very slight.

The investigations in the summer of 1912 point quite in the same direction (Fig. 4). We make the same observation here, that the specimens of the older series occur only in quite an insignificant quantity in proportion to the specimens of the 0-group, and here it should moreover be taken into consideration that the specimens of the I-group might originate from the fiord's own 0-group from 1911, and the specimens of the II-group from the fiord's own 0-group from 1910.

In the summer of 1911 the fishing experiments in the fiord showed about the same quantity of the 0-group and of the I-group, but only few of both groups (Fig. 3). The specimens of the I-group may originate from the fiord's own 0-group from 1910. But proportionately more specimens of the II-group occurred than in 1910 and 1912, and these must either have immigrated as I-group in the autumn of 1910 or in the winter of 1910—11, or as II-group in the period April—July 1911 [1]).

If we compare the captures of the 0-group of the plaice in Ringkøbing Fiord with the captures in Hjerting Fiord and in Nissum Bredning and the Limfiord, or the captures off the open West coast, we shall notice several conditions of peculiar interest (Fig. 7—10). In 1910 when the Hvide Sande canal was still narrow, from ca. 26—80 meters, considerably more plaice were captured per hour in the Hjerting Fiord, on the West coast of Fanø, Skallingen, and in the area Blaavand—Søndervig than in the Ringkøbing Fiord (Fig. 7). In the summer of 1911, when the breadth of the Hvide Sande canal had increased to 180 meters, the Ringkøbing Fiord was not so much behind the other localities, and in 1912 when the breadth of the Hvide Sande canal had increased to ca. 300 meters, the capture in Ringkøbing Fiord approaches still more the capture in Hjerting Fiord and Nissum Bredning, and now it surpassed quite the captures in the area Blaavand—Søndervig and Søndervig—Thyborøn.

The average numbers availlable here are as follows:

Year	Place	Average number of plaice of the 0-group pr. hour	Number of Stations
1910.	Ringkøbing Fiord	38	12
—	Hjerting Fiord	95	7
—	West side of Fanø—Skallingen	83	7
—	Blaavand—Søndervig	58	2
1911.	Ringkøbing Fiord	8	9
—	Hjerting Fiord	13	7
—	Nissum Bredning	35	6
—	West side of Fanø - Skallingen	8	7
—	Blaavand—Søndervig	12	6
—	Søndervig—Thyborøn	20	7
1912.	Ringkøbing Fiord	239	16
—	Hjerting Fiord	284	7
—	Nissum Bredning	482	7
—	West side of Fanø—Skallingen	337	4
—	Blaavand—Søndervig	56	5
—	Søndervig—Thyborøn.	121	7

[1]) We reckon here that the plaice were hatched on April 1st.

Fig. 1. The depths of Ringkøbing Fiord.

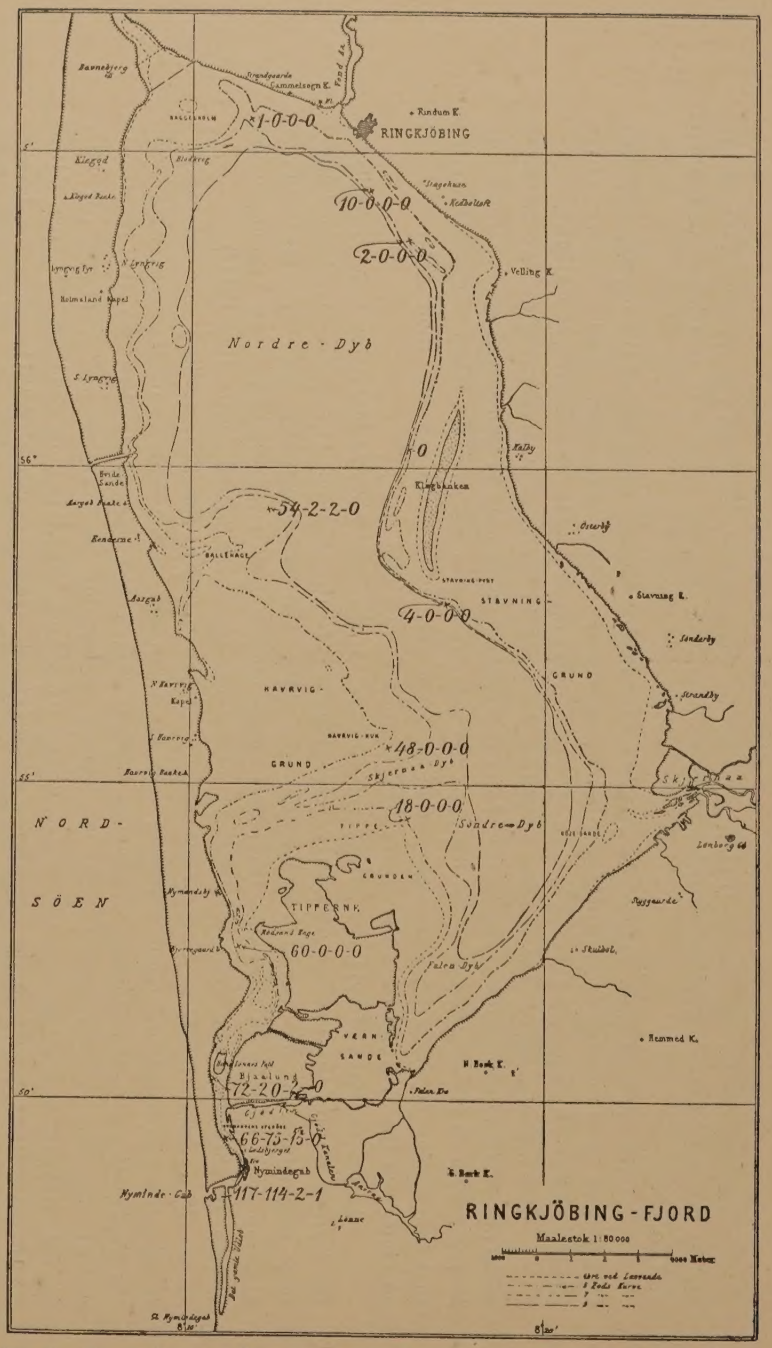

Fig. 2. No. of plaice of the various annual series captured per hour with Young Plaice Trawl, 1.—7. July 1910. First figure represents No. of 0-Gr.; second figure No. of I-Gr. and so on.

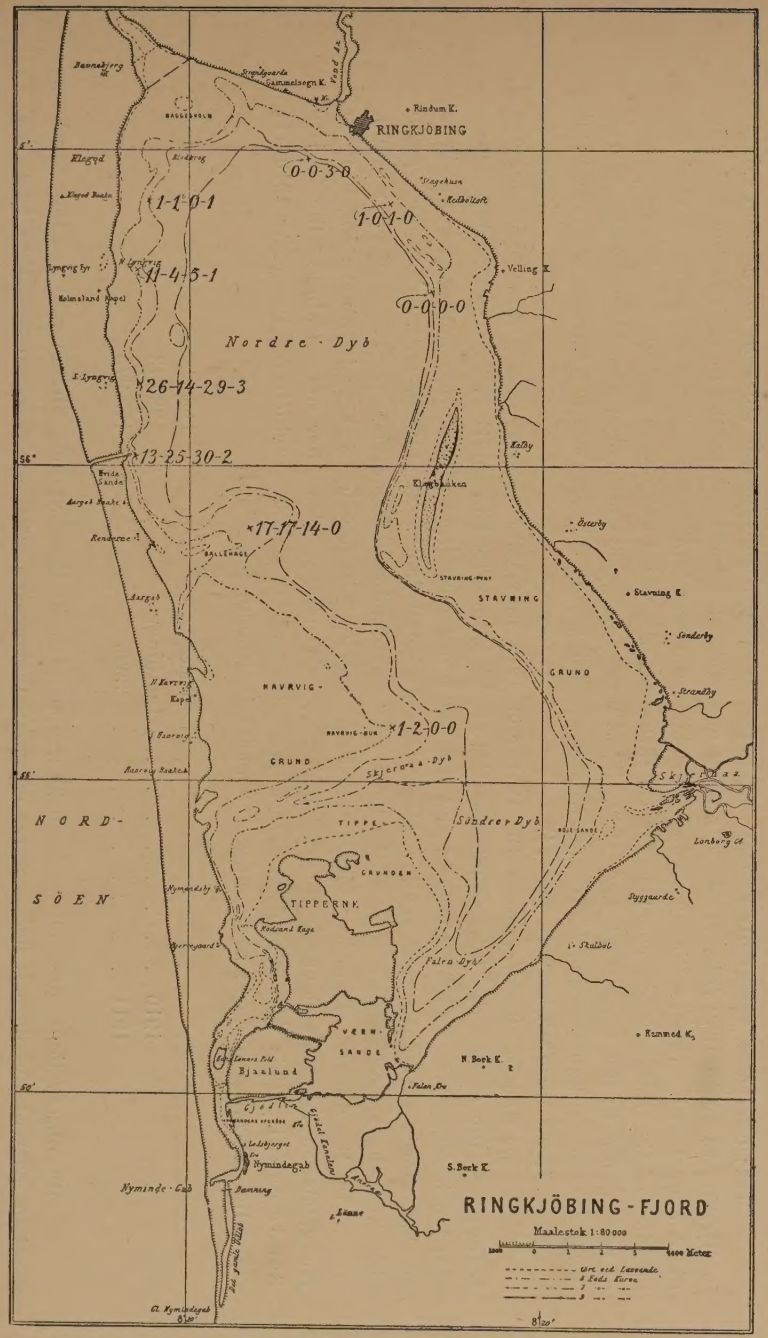

Fig. 3. No. of plaice of the various annual series captured per hour with Young Plaice Trawl, 18.—21. August 1911. First figure represents No. of 0-Gr.; second figure No. of I-Gr. and so on.

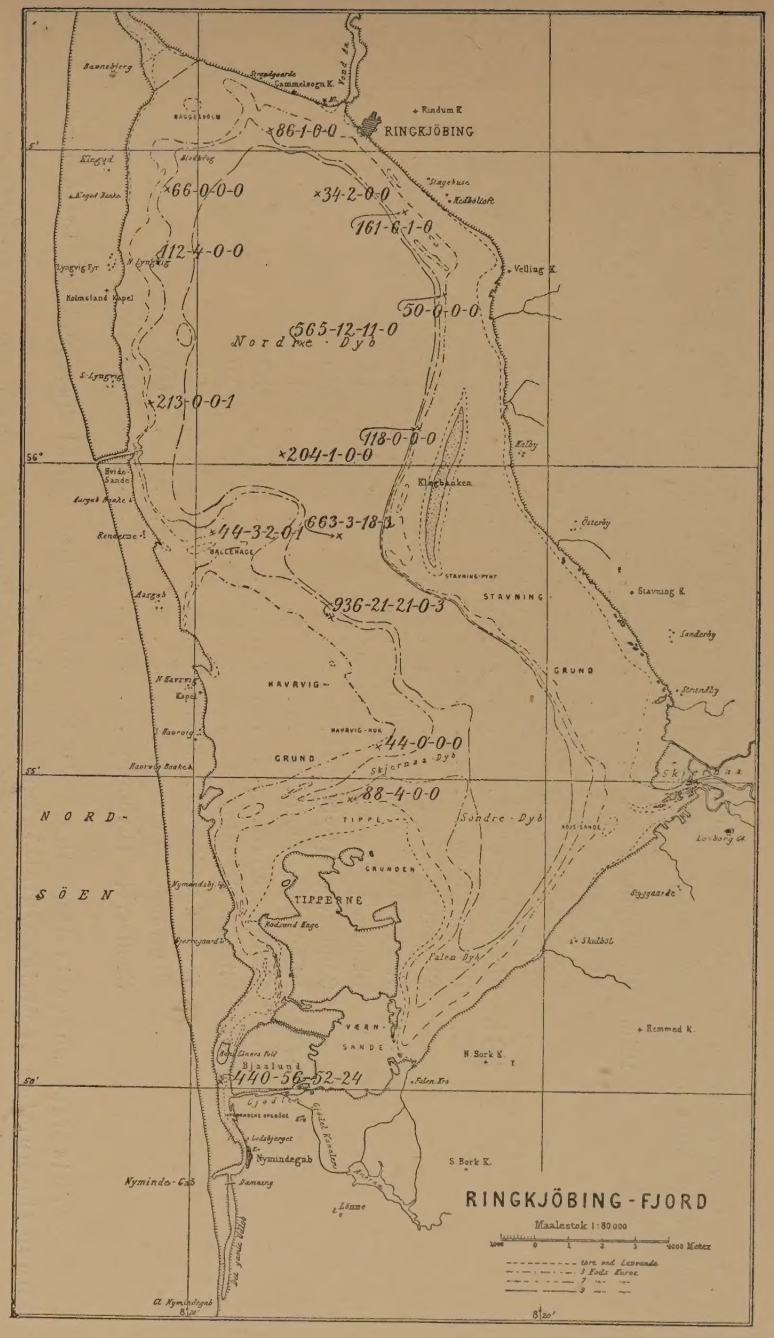

Fig. 4. No. of plaice of the various annual series captured per hour with Young Plaice Trawl, 14.—19. August 1912. First figure represents No. of 0-Gr.; second figure No. of I-Gr. and so on.

If we regard the average capture of the 0-group of the plaice in Ringkøbing Fiord as a unit for each of the three years, the capture will for the other areas look as follows:

1910.	Ringkøbing Fiord	1
—	Hjerting Fiord	2.5
—	West side of Fanø—Skallingen	2.2
—	Blaavand—Søndervig	1.5
1911.	Ringkøbing Fiord	1
—	Hjerting Fiord	1.6
—	Nissum Bredning	4.4
—	West side of Fanø—Skallingen	1.0
—	Blaavand—Søndervig	1.5
—	Søndervig—Thyborøn	2.5
1912.	Ringkøbing Fiord	1
—	Hjerting Fiord	1.2
—	Nissum Bredning	2.0
—	West side of Fanø—Skallingen	1.4
—	Blaavand—Søndervig	0.23
—	Søndervig—Thyborøn	0.5

This fact suggests that the very breadth of the canal has had an influence upon the number of plaice which invaded the fiord.

If we compare the captures of the I-group in Ringkøbing Fiord with the captures in Hjerting Fiord in 1910, it will be seen that the predominance is far greater for Hjerting Fiord for the I-group than it was for the 0-group (Fig. 12 and 8).

This originates, essentially at least, from the fact that a considerable stock of the 0-group existed in Hjerting Fiord in 1909 (Fig. 7) while in 1909 no stock at all existed of the 0-group of the plaice in Ringkøbing Fiord. (As mentioned before the plaice did not immigrate in the fiord itself till after the opening of the Hvide Sande canal in March 1910). If we regard the charts representing the frequency of the I-group in the years 1911 and 1912, it will be seen that Ringkøbing Fiord continually shows fewer specimens than Hjerting Fiord and Nissum Bredning, the difference is not however as prominent by far as it was in 1910 (Fig. 13 and 14).

As we find in all the years 1910, 1911 and 1912 that only proportionately few plaice of the I-group and the older series have immigrated into Ringkøbing Fiord in spring, it is natural to suppose that the immigrations into the Limfiord and Hjerting Fiord have been of a similar nature. The inlets of all these fiords are in the most shallow places of only small depth. It must be regarded as most probable that the spring immigrations to the fiords quite predominantly comprise specimens of the 0-group.

In the different years in which flat fish are captured in practical fishery in Ringkøbing Fiord a far greater number of flounder than of plaice occur generally, also after the opening of the Hvide Sande canal. This will already be seen from the official statistics, which for the years 1910—11 show the following captures of flounder and plaice in Ringkøbing Fiord:

	Plaice	Flounder
1910	(nothing)	128 873
1911	3925	173 875

By observations of captures in fishing apparatus in the Nyminde Stream and in the South-Eastern part of the fiord it has however appeared that just as many plaice as flounder may be caught

Table 1. No. of Plaice and Flounder caught in the Southern and South-Eastern part of the Ringkøbing Fiord.

Date	No. of Fish captured		Percentage		No. of Fish pr. Gill-net		Fishing apparatus	Place of capture
	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder		
1910. July 13.	5	300	2	98	—	—	Salmon-weel	Nyminde Stream
— Sept. 10.	30	100	23	77	—	—	Eel-Pound-nets	—
— — 12.	5	325	2	98	—	—	—	—
— — 16.	0	295	0	100	—	—	—	—
— — 20.	4	210	2	98	—	—	—	—
— — 26.	25	280	8	92	—	—	—	—
— — 27.	15	250	6	94	—	—	—	—
— — 23.	5	50	9	91	—	—	Eel-seine	—
— Nov. 16.	0	110	0	100	0	14	8 Gill-nets	—
— — 17.	10	100	9	91	1	13	8 —	—
— — 18.	0	200	0	100	0	22	9 —	—
— — 19.	42	160	21	79	5	17	9 —	—
— — 21.	6	210	3	97	1	23	9 —	—
— Dec. 2.	16	410	4	96	1	37	11 —	—
1911. Febr. 11.	53	56	49	51	9	9	6 —	—
— March 24.	26	35	43	57	7	9	4 —	—
— Sept. 23.	11	210	5	95	1	12	17 —	S.-Eastern part of Fiord
— — 24.	0	365	0	100	0	21	17 —	— —
— — 25.	0	425	0	100	0	25	17 —	— —
— Oct. 3.	12	185	6	94	1	11	17 —	— —
— — 4.	25	415	6	94	1	24	17 —	— —
— — 5.	0	570	0	100	0	34	17 —	— —
— — 9.	25	695	3	97	1	41	17 —	— —
— — 10.	20	450	4	96	1	26	17 —	— —
— — 11.	15	360	4	96	1	21	17 —	— —
— — 12.	0	685	0	100	0	40	17 —	— —
— — 17.	30	275	10	90	2	16	17 —	— —
— — 18.	5	415	1	99	0	24	17 —	— —
— — 19.	25	395	6	94	1	23	17 —	— —
— — 21.	30	205	13	87	2	12	17 —	— —
— — 28.	3	90	3	97	1	15	6 —	— —
— Nov. 15.	94	14	87	13	16	2	6 —	Nyminde Stream
— — 29.	110	275	29	71	11	28	10 —	—
— — 30.	223	236	49	51	22	24	10 —	—
— Dec. 1.	213	255	46	54	13	16	16 —	—
— — 2.	263	174	60	40	16	11	16 —	—
— — 4.	545	165	77	23	34	10	16 —	—
— — 7.	653	137	83	17	36	8	18 —	—
— — 8.	265	65	80	20	27	7	10 —	—
— — 9.	157	71	69	31	16	7	10 —	—
— — 11.	326	170	66	34	16	9	20 —	—
— — 14.	423	175	71	29	26	11	16 —	—
— — 16.	266	154	63	37	17	10	16 —	—
— — 18.	381	140	73	27	24	9	16 —	—
— — 20.	157	75	68	32	13	6	12 —	—
1912. Jan. 3.	82	65	56	44	10	8	8 —	—
— — 5.	127	102	56	44	11	9	12 —	—
— — 14.	100	75	57	43	50	38	2 —	—
— — 15.	74	79	48	52	37	40	2 —	—
— — 16.	109	91	55	45	44	36	$2^1/_2$ —	—
— — 17.	126	120	51	49	42	40	3 —	—
— — 18.	117	65	64	36	59	33	2 —	—
— — 19.	110	55	67	33	37	18	3 —	—
— — 20.	97	80	55	45	49	40	2 —	—
— — 23.	143	53	73	27	34	18	3 —	—
— — 25.	186	65	74	26	62	22	3 —	—
— — 27.	70	49	59	41	28	20	$2^1/_2$ —	—
— — 29.	102	55	65	35	41	22	$2^1/_2$ —	—
— Febr. 2.	55	5	92	8	55	5	1 —	—
— — 5.	114	35	77	23	36	10	$3^1/_2$ —	—
— — 7.	33	33	50	50	22	22	$1^1/_2$ —	—
— — 12.	69	35	66	34	46	23	$1^1/_2$ —	—
— — 17.	54	25	68	32	36	17	$1^1/_2$ —	—
— — 18.	68	17	80	20	45	11	$1^1/_2$ —	—
— — 20.	168	38	82	18	84	19	2 —	—
— — 21.	211	34	86	14	70	11	3 —	—
— — 22.	175	41	81	19	58	14	3 —	—
— — 24.	180	14	93	7	45	4	4 —	—
— March 2.	31	78	28	72	4	10	8 —	—
— — 3.	25	19	57	43	4	3	6 —	—

(Table 1 continued.)

Date	No. of Fish captured		Percentage		No. of Fish pr. Gill-net		Fishing apparatus	Place of capture
	Plaice	Flounder	Plaice	Flounder	Plaice	Flounder		
1912. March 9.	18	7	72	28	5	2	4 Gill-nets	Nyminde Stream
— — 26.	41	8	84	16	21	4	2 —	—
— May 28.	47	230	17	83	—	—	Eel-weel	—
— June 5.	15	250	6	94	4	63	4 Gill-nets	—
— Oct. 24.	15	125	11	89	2	16	8 —	—
— — 26.	28	195	13	87	4	24	8 —	—
— — 28.	12	55	18	82	2	9	6 —	—
— — 29.	0	35	0	100	0	6	8 —	—
— Dec. 18.	0	151	—	100	0	11	14 —	—
— — 28.	8	190	4	96	1	16	12 —	—
1913. Jan. 6.	8	69	10	90	1	7	10 —	—
— — 7.	6	90	6	94	1	9	10 —	—
— — 24.	3	44	6	94	1	11	4 —	—
— — 25.	1	54	2	98	0	14	4 —	—
— — 28.	1	26	4	96	1	26	1 —	—
— — 30.	3	152	2	98	1	38	4 —	—
— Febr. 1.	5	211	2	98	1	60	$3^1/_2$ —	—
— — 8.	2	46	4	96	0	8	6 —	—
— — 11.	8	141	5	95	2	28	5 —	—
— — 12.	12	107	10	90	1	12	9 —	—
— — 14.	15	126	11	89	—	—	— —	—

If we summarize the figures of Tab. 1,
we get the following result:

Month	No. of Fish captured		Percentage	
	Plaice	Flounder	Plaice	Flounder
1910. July	5	300	2	98
— Sept.	84	1510	5	95
— Novbr.	58	780	7	93
— Decbr.	16	410	4	96
1911. Febr.	53	56	49	51
— March	26	35	43	57
— Sept.	11	1000	1	99
— Oct.	190	4740	4	96
— Novbr.	427	525	45	55
— Decbr.	3649	1581	70	30
1912. Jan.	1443	954	60	40
— Febr.	1127	277	80	20
— March	115	112	51	49
— May	47	230	17	83
— June	15	250	6	94
— Oct.	55	410	12	88
— Decbr.	8	341	2	98
1913. Jan.	22	435	5	95
— Febr.	42	631	6	94

According to Table 1 we get the following
No. of Plaice and Flounder caught pr. Gill net in the Ringkøbing Fiord.

Month	No. of Fish captured pr. Gill net		Month	No. of Fish captured pr. Gill net	
	Plaice	Flounder		Plaice	Flounder
1910. Novbr.	1.35	18.14	1912. Jan.	30.38	20.08
— Decbr.	1.45	37.27	— Febr.	50.09	12.31
			— March	5.75	5.60
1911. Febr.	8.83	9.33	— June	3.75	62.50
— March	6.50	8.75	— Oct.	1.83	13.67
— Sept.	0.22	19.61	— Decbr.	0.31	13.12
— Oct.	0.98	24.56			
— Novbr.	16.42	20.19	1913. Jan.	0.67	13.18
— Decbr.	21.98	9.52	— Febr.	1.79	26.85

in autumn and winter and sometimes even considerably more. This must arise from the fact that a considerable immigration of plaice takes place to the fiord in autumn. If we look at table 1, which represents the capture of plaice and flounder for a longer period, it will be seen that the capture of flounder is about the same at all seasons of the year, but that the capture of plaice in two of the three winters in the period 1910—13 has surpassed the summer capture many times. As the plaice otherwise in shallow water show an inclination to squeeze themselves into the bottom in winter,

Fig. 5. Percentage of Plaice and Flounder caught in the Ringkøbing Fiord in the various months from July 1910 till February 1913.

this difference in the capture must be explained in the way that the stock of plaice has been many times greater in winter than in summer.

Table 1 shows that the great captures of plaice began very suddenly in November 1911. An enormous immigration of fish must then have taken place, and it seemed to have continued for some time. In the autumn of 1910 (or in the winter of 1910—11) the immigration of plaice seems to have

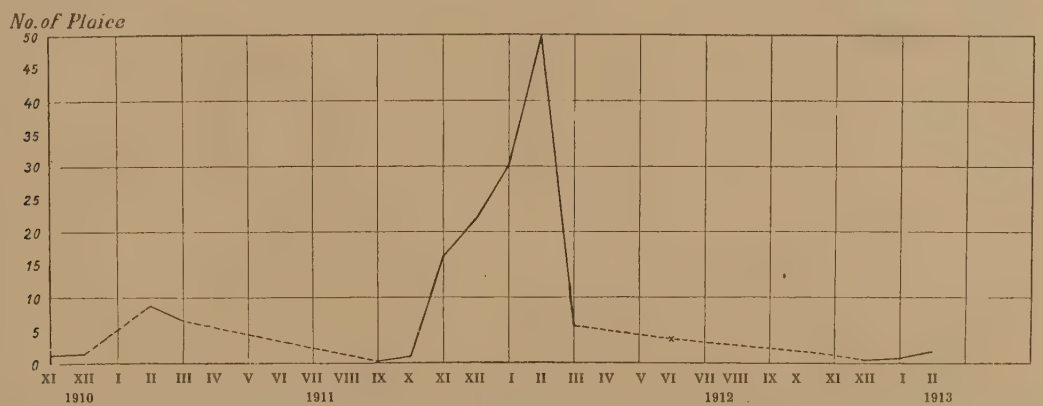

Fig. 6. No. of Plaice caught per Gill net in the Ringkøbing Fiord in the various months from November 1910 till February 1913.

been less considerable. In the winter of 1912—13 no immigration of plaice to the Nyminde Stream could be traced. The immigration was however plainly observable in other parts of the fiord (Tipperne, Falen Deep) but observations as to the exact numbers of individuals captured there are not to hand.

A priori it might be supposed that the majority of the numerous plaice which were captured in the Nyminde Stream in the winter of 1910—11 and especially in 1911—12, might originate from one of the following places:

1) the Nyminde Stream itself
2) the Ringkøbing Fiord
3) the North Sea.

In the Nyminde Stream the majority of the specimens can certainly not have grown up. In this case the enormous difference in the summer and winter captures as shown by table 1 and Fig. 6 would not have occurred. Moreover it is quite improbable in such a small area as the Nyminde Stream that so many plaice should grow up, that the captures could become as great as they were especially in the winter of 1911—12.

In the Ringkøbing Fiord the majority of the plaice cannot have grown up either. The fishing experiments in the summer of 1910, 1911 and 1912 showed that the specimens older than the 0-group were only few. Were we however to suppose that they had grown up in Ringkøbing Fiord, we must imagine that they must have originated chiefly from the 0-group immigrated in 1910, but though the two youngest series of the plaice grow proportionately quickly in Ringkøbing Fiord, the specimens of the 0-group from 1910 could not have reached the size of the majority captured in the winter of 1911—12. This may be seen by comparing table 2 (which represents the measurements of plaice caught in Ringkøbing Fiord in the winter of 1911—12), with the tables 3—7 which represent the size of the various annual series of plaice captured in Ringkøbing Fiord in 1910—1912.

The specimens of the 0-group from 1910 had in the winter of 1911—12 (as I-group) attained a size between I-group in 1911 and II-group in 1912, but even the specimens of this last series had by far not obtained the size of the majority of the plaice captured in 1911—12.

The plaice captured in the Nyminde Stream with gill nets between 15. November 1911 and 26. March 1912 had the following size:

Length in cm	Total number	Calculated pro 10 000 specimens
13	5	7
14	11	17
15	27	41
16	53	80
17	96	144
18	180	271
19	263	395
20	365	549
21	507	762
22	720	1 082
23	891	1 339
24	981	1 475
25	1110	1 669
26	647	973
27	374	562
28	218	328
29	117	176
30	64	96
31	16	24
32	7	10
	Total: 6652	10 000

The average size of those 6652 plaice was 23.4 cm and 38.4 per cents of them had a length above 24 cm. The average size of the specimens of the II-group captured in August 1912 in the fiord was only 18.6 cm and none reached a size beyond 24 cm (compare the tables 6—7). The specimens of the II-group which were captured in the fiord in 1911 were of a similar size as those captured in August 1912, namely of an average length of 19.1 cm (Table 5).

Table 2. Size of Plaice captured in the Nyminde Stream with Gill-nets (those of 28.—5.—1912 captured with Eel-weel).

Datum	15. Nov. 1911	22. Nov. 1911		1. Dec. 1911		2. Dec. 1911		4. Dec. 1911		7. Dec. 1911		8. Dec. 1911		9. Dec. 1911		11. Dec. 1911		14. Dec. 1911		16. Dec. 1911		18. Dec. 1911	
Sex	♂+♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
13 cm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—
15 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
16 —	—	1	2	—	—	—	—	1	—	—	1	—	—	—	—	1	—	1	—	1	—	—	—
17 —	—	1	—	—	—	—	1	1	1	1	2	—	1	1	—	1	1	1	1	2	1	1	1
18 —	1	1	1	1	—	—	1	2	2	4	1	1	2	1	–	2	1	1	2	3	1	2	1
19 —	2	5	3	2	1	1	1	6	6	4	5	2	2	—	1	4	2	4	3	2	2	1	2
20 —	2	5	11	5	2	4	3	9	12	10	9	4	6	2	3	5	1	6	8	5	3	5	3
21 —	6	11	12	—	4	3	3	17	16	23	18	10	6	3	5	6	11	10	13	9	7	9	10
22 —	12	12	14	5	10	8	9	27	20	37	30	11	11	8	6	8	19	23	23	19	16	12	19
23 —	10	10	13	21	17	16	19	45	35	55	35	18	21	9	12	17	19	30	22	27	14	27	21
24 —	14	18	15	24	15	20	22	46	40	62	48	27	18	18	16	30	18	39	23	25	14	33	35
25 —	20	18	16	18	19	25	27	54	58	83	53	33	20	19	15	45	31	47	35	36	25	45	40
26 —	12	8	10	12	13	20	25	29	35	52	30	24	15	11	7	24	21	28	26	15	14	29	25
27 —	8	7	8	10	9	10	14	18	22	19	26	6	11	5	5	15	15	12	17	4	8	13	11
28 —	3	5	5	8	6	6	10	10	15	12	16	7	2	2	3	4	11	10	10	5	3	7	9
29 —	2	3	4	4	3	2	6	7	7	4	4	1	1	1	2	2	9	6	7	1	3	4	5
30 —	1	1	2	2	1	3	3	2	2	3	4	1	2	1	1	1	2	5	4	—	—	2	3
31 —	1	—	1	1	—	—	1	1	—	—	1	1	—	—	—	—	—	2	2	—	1	1	1
32 —	—	—	—	—	—	—	—	—	—	1	—	1	—	—		—	—	1	—	—	—	2	1
Total number	94	106	117	113	100	118	145	275	271	370	283	147	118	81	76	165	161	227	196	154	112	194	187
Average length cm	24.3	23.7	23.7	24.7	24.6	24.7	25.0	24.1	24.0	24.1	24.2	24.3	23.9	24.2	24.2	24.3	24.6	24.4	24.4	23.6	24.1	24.5	24.5

Datum	20. Dec. 1911		3. Jan. 1912		5. Jan. 1912		14. Jan. 1912		15. Jan. 1912		16. Jan. 1912		17. Jan. 1912		18. Jan. 1912		19. Jan. 1912		20. Jan. 1912		c. 23. Jan. 1912	
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
13 cm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
14 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
15 —	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	—	1	—	—	—	—	2
16 —	—	—	1	—	—	1	—	—	—	—	—	—	—	—	1	1	—	—	—	1	—	—
17 —	1	—	1	—	—	—	—	—	—	1	1	—	—	—	—	1	—	—	1	—	2	—
18 —	1	—	—	1	2	—	1	—	—	—	3	1	—	—	1	1	—	1	—	—	3	—
19 —	2	4	—	—	2	1	4	2	1	—	5	—	1	1	2	1	—	1	2	1	5	3
20 —	1	3	3	1	3	6	4	5	5	1	7	3	5	3	—	3	1	4	3	3	8	3
21 —	3	3	4	3	9	6	6	3	3	4	2	7	7	2	3	4	7	6	6	1	9	6
22 —	7	5	3	3	2	5	7	4	5	2	5	13	9	12	11	5	8	7	8	6	12	12
23 —	16	11	1	9	15	8	8	6	9	5	14	8	12	9	10	9	11	12	9	11	9	11
24 —	18	8	10	9	11	10	10	7	7	2	9	4	13	4	9	7	9	10	7	4	15	8
25 —	14	15	9	6	12	11	13	5	5	6	7	6	11	10	12	11	9	8	11	5	11	7
26 —	7	11	4	4	5	8	6	2	4	2	3	3	4	6	7	5	5	4	6	5	6	2
27 —	4	10	3	2	3	5	3	—	4	3	2	1	5	5	3	5	2	2	—	4	—	—
28 —	4	8	1	—	—	1	1	—	1	1	1	1	1	4	—	1	—	1	1	1	1	3
29 —	—	1	1	1	—	1	1	2	1	—	1	1	—	—	1	—	—	—	—	1	1	2
30 —	—	—	—	2	—	—	—	—	—	—	—	1	—	—	—	2	1	—	—	—	—	1
31 —	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—
32 —	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—
Total number	78	79	41	41	64	63	64	36	46	28	60	49	68	58	61	56	54	56	54	43	82	61
Average length cm	23.9	24.5	23.7	24.7	23.2	23.7	23.4	23.1	23.7	23.4	22.7	23.1	23.4	23.9	23,4	23.7	23.4	23.2	23.2	23.7	22.6	22.9

(Table 2 continued.)

Datum	25. Jan. 1912		27. Jan. 1913		29. Jan. 1912		2. Febr. 1912		5. Febr. 1912		7. Febr. 1912		12. Febr. 1912		17. Febr. 1912		18. Febr. 1912		20. Febr. 1912		21. Febr. 1912	
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
13 cm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
14 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
15 —	—	1	—	—	1	1	2	—	—	1	—	—	—	—	—	—	—	—	—	2	1	3
16 —	—	—	—	—	2	—	—	—	—	1	—	—	—	—	—	1	1	1	—	2	1	3
17 —	1	1	1	1	1	2	—	1	2	1	—	1	1	—	—	—	1	2	3	3	8	1
18 —	4	2	2	1	3	1	1	2	2	1	1	1	2	2	—	1	2	1	11	10	17	10
19 —	4	7	2	2	2	1	—	1	8	2	3	3	1	1	3	1	3	2	14	16	12	13
20 —	5	4	4	5	2	2	3	2	9	4	3	—	1	7	2	6	2	6	6	9	16	10
21 —	10	3	5	4	4	4	3	—	10	5	2	2	4	2	5	4	5	4	12	14	18	17
22 —	12	12	9	6	9	6	2	5	7	10	4	1	4	6	3	4	3	3	9	15	16	13
23 —	22	10	5	2	8	5	6	2	2	11	1	1	3	3	8	—	7	1	5	11	11	9
24 —	24	10	5	3	11	6	8	4	7	5	5	—	5	7	4	3	5	4	8	7	7	5
25 —	15	11	3	4	8	5	2	3	7	7	—	3	7	6	2	1	3	3	1	2	8	5
26 —	3	5	1	2	4	2	2	1	4	3	—	2	1	—	3	1	3	1	2	2	—	2
27 —	3	5	—	1	2	2	1	1	1	1	—	—	1	—	2	—	2	1	—	1	1	1
28 —	1	3	—	—	2	1	—	—	—	1	—	—	1	2	—	—	1	—	—	—	1	1
29 —	2	2	—	1	1	1	1	1	1	1	—	—	—	1	—	—	1	—	—	—	—	—
30 —	2	2	1	—	2	1	—	1	—	—	—	—	1	—	—	—	—	—	—	1	—	—
31 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
32 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total number	108	78	38	32	62	40	31	24	60	54	19	14	32	37	32	22	39	29	72	96	117	94
Average length cm	23.2	23.3	22.1	22.3	23.0	23.0	22.7	23.0	21.9	22.6	21.5	21.9	23.1	22.7	22.8	21.3	22.6	21.5	20.6	21.0	20.7	20.8

Datum	22. Febr. 1912		24. Febr. 1912		2. March 1912		3. March 1912		9. March 1912		26. March 1912		c. 28. May 1912		5. June 1912	24. Oct. 1912	26. Oct. 1912	28. Oct. 1912
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂+♀	♂+♀	♂+♀	♂+♀
11 cm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
13 —	—	—	—	4	—	—	—	—	—	—	—	—	—	1	—	—	—	—
14 —	—	2	4	1	—	—	—	—	—	—	—	—	1	—	—	—	—	—
15 —	1	2	2	4	—	—	—	1	—	—	—	—	2	2	—	—	—	—
16 —	2	5	6	13	—	—	—	—	—	—	—	1	5	5	—	—	—	—
17 —	4	10	8	13	1	—	1	1	—	—	1	—	5	2	—	—	—	—
18 —	9	12	14	15	—	—	2	—	1	1	2	1	1	1	—	—	—	1
19 —	13	11	16	8	4	2	1	1	4	1	1	1	—	—	—	1	1	1
20 —	7	12	19	8	3	2	—	1	2	1	2	2	5	2	—	3	1	3
21 —	15	7	10	10	2	1	1	1	1	1	3	2	7	2	—	3	7	2
22 —	13	12	8	5	1	—	1	3	2	1	4	1	1	1	1	2	7	2
23 —	3	7	4	3	2	2	3	1	—	—	5	2	—	3	2	1	2	2
24 —	7	4	1	1	3	2	—	2	1	—	3	3	1	—	1	2	4	1
25 —	7	2	2	—	—	1	2	1	1	—	1	1	—	—	5	2	3	—
26 —	4	2	—	—	1	—	—	—	—	—	1	1	—	—	2	—	3	—
27 —	1	—	—	—	3	—	—	1	—	1	1	2	1	—	2	—	—	—
28 —	—	—	—	1	—	1	—	1	—	—	—	—	—	—	1	—	—	—
29 —	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
30 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
31 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
32 —	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Total number	86	89	94	86	20	11	11	14	12	6	24	17	29	19	15	14	28	12
Average length cm	21.0	19.9	19.2	18.3	22.1	22.4	21.3	22.1	20.7	21.2	22.0	22.4	18.9	18.3	25.3	22.7	22.7	21.1

(Table 2 continued.)

Datum	28. Dec. 1912	6. Jan. 1913	7. Jan. 1913	24. Jan. 1913	25. Jan. 1913	28. Jan. 1913	30. Jan. 1913	1. Febr. 1913	8. Febr. 1913	11. Febr. 1913	12. Febr. 1913	14. Febr. 1913
Sex	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀	♂ + ♀
13 cm	—	—	—	—	—	—	—	—	—	1	—	—
14 —	—	—	—	—	—	—	—	—	—	—	—	—
15 —	—	—	—	—	—	—	—	—	—	—	—	—
16 —	—	—	—	—	—	—	—	—	—	—	—	—
17 —	—	—	—	—	—	—	—	1	—	—	—	1
18 —	1	—	—	—	—	—	—	1	—	1	2	2
19 —	2	—	—	1	—	—	1	—	—	—	2	3
20 —	1	—	—	2	—	—	1	—	1	2	2	2
21 —	1	—	—	—	1	—	—	1	—	1	2	3
22 —	2	—	2	—	—	1	—	1	—	1	4	1
23 —	1	—	—	—	—	—	—	1	—	2	—	2
24 —	—	2	1	—	—	—	—	—	1	—	—	1
25 —	—	3	2	—	—	—	1	—	—	—	—	—
26 —	—	2	1	—	—	—	—	—	—	—	—	—
27 —	—	—	—	—	—	—	—	—	—	—	—	—
28 —	—	—	—	—	—	—	—	—	—	—	—	—
29 —	—	1	—	—	—	—	—	—	—	—	—	—
30 —	—	—	—	—	—	—	—	—	—	—	—	—
31 —	—	—	—	—	—	—	—	—	—	—	—	—
32 —	—	—	—	—	—	—	—	—		—	—	—
Total number	8	8	6	3	1	1	3	5	2	8	12	15
Average length cm	20.5	25.5	24.0	19.7	21.0	22.0	21.3	20.2	22.0	20.3	20.3	20.3

Table 3. Size and age of Plaice captured in the Ringkøbing Fiord. 4.—7. July 1910.
St. 1427, 1430, 1432—33, 1437—39.

Reckoned from 1. April	Age-group	0	I	II	Total
	Age in years	$^3/_{12}$	$1\ ^3/_{12}$	$2\ ^3/_{12}$	
Length in cm					
3		2	—	—	2
4		4	—	—	4
5		8	—	—	8
6		18	—	—	18
7		32	—	—	32
8		17	—	—	17
16		—	1	—	1
20		—	—	1	1
Total		81	1	1	83
Average length		6.5	16.0	20.0	—

Table 4. Size and age of Plaice captured in the Nyminde Stream (part of Ringkøbing Fiord), 1.—4. July 1910.
St. 1423.—26.

Reckoned from 1. April	Age-group	0	I	II	III	Total
	Age in years	$^3/_{12}$	$1\ ^3/_{12}$	$2\ ^3/_{12}$	$3\ ^3/_{12}$	
Length in cm						
2		1	—	—	—	1
3		25	—	—	—	25
4		107	—	—	—	107
5		49	—	—	—	49
6		25	—	—	—	25
7		7	1	—	—	8
8		—	5	—	—	5
9		—	34	—	—	34
10		—	55	—	—	55
11		—	40	—	—	40
12		—	20	—	—	20
13		—	5	—	—	5
14		—	7	—	—	7
15		—	5	—	—	5
16		—	2	2	—	4
17		—	3	3	—	6
18		—	1	2	—	3
20		—	—	1	—	1
25		—	—	—	1	1
Total		214	178	8	1	401
Average length		4.4	10.8	17.4	25.0	—

Table 5. Size and age of Plaice captured in the Ringkøbing Fiord from 18.—21. August 1911.
St. 1734—38, 1740, 1746, 1748.

Sex	♂					♀					♂ + ♀					
Reckoned from 1. April / Age-group	I	II	III	?	Total	I	II	III	?	Total	0	I	II	III	?	Total
Age in years	1 5/12	2 5/12	3 5/12	?		1 5/12	2 5/12	3 5/12	?		5/12	1 5/12	2 5/12	3 5/12	?	
Length in cm																
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
6	—	—	—	—	—	—	—	—	—	—	9	—	—	—	—	9
7	—	—	—	—	—	—	—	—	—	—	14	—	—	—	—	14
8	—	—	—	—	—	—	—	—	—	—	8	—	—	—	—	8
9	—	—	—	—	—	—	—	—	—	—	17	—	—	—	—	17
10	—	—	—	—	—	—	—	—	—	—	14	—	—	—	—	14
11	2	—	—	—	2	2	—	—	1	3	7	4	—	—	1	12
12	2	—	—	—	2	1	—	—	—	1	—	3	—	—	—	3
13	1	—	—	—	1	4	—	—	—	4	—	5	—	—	—	5
14	3	—	—	—	3	7	1	—	—	8	—	10	1	—	—	11
15	3	—	—	1	4	8	—	—	2	10	—	11	—	—	3	14
16	4	1	—	1	6	4	3	—	1	8	—	8	4	—	2	14
17	2	4	—	2	8	8	4	—	1	13	—	10	8	—	3	21
18	3	9	—	2	14	5	8	—	2	15	—	8	17	—	4	29
19	2	6	—	—	8	1	9	—	2	12	—	3	15	—	2	20
20	—	12	1	—	13	—	8	3	3	14	—	—	20	4	3	27
21	—	7	1	1	9	—	4	—	3	7	—	—	11	1	4	16
22	—	2	—	—	2	—	1	1	—	2	—	—	3	1	—	4
23	1	—	—	—	1	—	1	—	—	1	—	1	1	—	—	2
24	—	—	1	—	1	—	—	—	—	—	—	—	—	1	—	1
Total	23	41	3	7	74	40	39	4	15	98	70	63	80	7	22	242
Average length	15.6	19.3	21.7	—	—	15.3	18.8	20.5	—	—	8.4	15.4	19.1	21.0	—	—

Table 6. Size and age of Plaice captured in the Ringkøbing Fiord 14.—19. August 1912.
St. 1920—1935.

Reckoned from 1. April / Age-group	0	I	II	III	IV	?	Total
Age in years	c. 5/12	c. 1 5/12	c. 2 5/12	c. 3 5/12	c. 4 5/12	?	
Length in cm							
3	3	—	—	—	—	—	3
4	206	—	—	—	—	—	206
5	493	—	—	—	—	—	493
6	528	—	—	—	—	—	528
7	450	—	—	—	—	—	450
8	288	—	—	—	—	—	288
9	158	—	—	—	—	—	158
10	97	—	—	—	—	—	97
11	30	2	—	—	—	—	32
12	—	3	—	—	—	—	3
13	—	3	—	—	—	—	3
14	—	4	—	—	—	—	4
15	—	11	1	—	—	—	12
16	—	10	3	—	—	—	13
17	—	10	10	—	—	1	21
18	—	4	6	2	—	—	12
19	—	3	6	1	—	—	10
20	—	1	10	1	—	—	12
21	—	—	2	1	—	—	3
22	—	—	—	—	—	—	—
23	—	—	1	2	1	—	4
24	—	—	1	1	—	—	2
25	—	—	—	—	1	—	1
Total	2253	51	40	8	2	1	2355
Average length	6.5	15.6	18.6	20.8	24.0	—	—

Table 7. Size and age of Plaice captured in the Nyminde Stream, Ringkøbing Fjord, 17. August 1912.
St. 1933.

Reckoned from 1. April	Age-group	0	I	II	III	Total
	Age in years	c. $^{5}/_{12}$	c. 1 $^{5}/_{12}$	c. 2 $^{5}/_{12}$	c. 3 $^{5}/_{12}$	
Length in cm						
8		2	—	—	—	2
9		22	—	—	—	22
10		59	—	—	—	59
11		27	—	—	—	27
12		—	—	—	—	—
13		—	—	—	—	—
14		—	2	—	—	2
15		—	4	—	—	4
16		—	3	1	—	4
17		—	2	3	—	5
18		—	3	1	2	6
19		—	—	2	—	2
20		—	—	5	—	5
21		—	—	1	1	2
22		—	—	—	—	—
23		—	—	—	2	2
24		—	—	—	1	1
Total		110	14	13	6	143
Average length		10.0	16.0	18.8	21.2	—

Table 8. Size and age of Plaice captured in the North Sea close S. and N. of Nymindegab. 12. July 1910.
S. 1447—48.

Reckoned from 1. April	Age-group	0	1	Total
	Age in years	$^{3}/_{12}$	1 $^{3}/_{12}$	
Length in cm				
4		3	—	3
5		53	—	53
6		2	—	2
7		—	—	—
8		—	4	4
9		—	12	12
10		—	5	5
11		—	—	—
12		—	1	1
Total		58	22	80
Average length		5.0	9.2	—

Table 9. Size and age of Plaice captured in the North Sea from off Kærgaarde Bn. to off S. Lyngvig. 3.—4. August 1911.
St. 1680—1685.

Sex		♂			♀			♂ + ♀			
Reckoned from 1. April	Age-group	I	II	Total	I	II	Total	0	I	II	Total
	Age in years	1 $^{4}/_{12}$	2 $^{4}/_{12}$		1 $^{4}/_{12}$	2 $^{4}/_{12}$		$^{4}/_{12}$	1 $^{4}/_{12}$	2 $^{4}/_{12}$	
Length in cm											
4		—	—	—	—	—	—	7	—	—	7
5		—	—	—	—	—	—	42	—	—	42
6		—	—	—	—	—	—	28	—	—	28
7		—	—	—	—	—	—	1	—	—	1
8		—	—	—	—	—	—	—	—	—	—
9		12	—	12	12	—	12	—	24	—	24
10		20	—	20	31	—	31	—	51	—	51
11		6	—	6	16	—	16	—	22	—	22
12		1	—	1	1	—	1	—	2	—	2
13		—	—	—	1	—	1	—	1	—	1
14		—	1	1	—	—	—	—	—	1	1
17		—	—	—	1	—	1	—	1	—	1
21		—	—	—	—	2	2	—	—	2	2
Total		39	1	40	62	2	64	78	101	3	182
Average length		9.9	14.0	—	10.3	21.0	—	5.3	10.1	18.7	—

Table 10. Size and age of Plaice captured in the North Sea from off Vedersø to 1 mile N. of Harboøre. 4. August 1911.
St. 1686—1691.

Sex	♂	♀	♂ + ♀		
Reckoned from 1. April — Age-group	I	I	0	I	Total
Age in years	1 4/12	1 4/12	4/12	1 4/12	
Length in cm					
4	—	—	10	—	10
5	—	—	67	—	67
6	—	—	46	—	46
7	—	—	—	—	—
8	—	—	—	—	—
9	2	2	—	4	4
10	4	1	—	5	5
11	7	9	—	16	16
12	4	4	—	8	8
13	—	4	—	4	4
Total	17	20	123	37	160
Average length	10.8	11.4	5.3	11.1	—

Table 11. Size and age of Plaice captured in the North Sea from 2 miles S. of Kærgaarde Bn. to off Haurvig Beacon. 3. August 1912.
St. 1894—1898.

Sex	♂			♀					♂ + ♀					
Reckoned from 1. April — Age-group	I	II	Total	I	II	III	?	Total	0	I	II	III	?	Total
Age in years	1 4/12	2 4/12		1 4/12	2 4/12	3 4/12	?		4/12	1 4/12	2 4/12	3 4/12	?	
Length in cm														
4	—	—	—	—	—	—	—	—	4	—	—	—	—	4
5	—	—	—	—	—	—	—	—	137	—	—	—	—	137
6	—	—	—	—	—	—	—	—	109	—	—	—	—	109
7	—	—	—	—	—	—	—	—	7	—	—	—	—	7
8	—	—	—	—	—	—	—	—	5	—	—	—	—	5
9	1	—	1	—	—	—	—	—	1	1	—	—	—	2
10	5	—	5	5	—	—	—	5	—	10	—	—	—	10
11	2	—	2	—	—	—	1	1	—	2	—	—	1	3
12	1	—	1	1	—	—	—	1	—	2	—	—	—	2
13	—	—	—	1	—	1	—	2	—	1	—	1	—	2
14	—	1	1	—	—	—	—	—	—	—	1	—	—	1
15	—	1	1	—	—	—	—	—	—	—	1	—	—	1
16	—	—	—	—	1	—	—	1	—	—	1	—	—	1
Total	9	2	11	7	1	1	1	10	263	16	3	1	1	284
Average length	10.3	14.5	—	10.7	16.0	13.0	—	—	5.5	10.5	15.0	13.0	—	—

Table 12. Size and age of Plaice captured in the North Sea from off Vedersø Beacon to off Harboøre. 4. August 1912.
St. 1899—1904.

Sex	♂ + ♀		
Reckoned from 1. April — Age-group	0	I	Total
Age in eyars	4/12	1 4/12	
Length in cm			
4	1	—	1
5	84	—	84
6	291	—	291
7	29	—	29
8	1	1 (?)	2
9	—	—	—
10	—	—	—
11	—	—	—
12	—	1 (♀)	1
13	—	1 (♂)	1
Total	406	3	409
Average length	5.9	11.0	—

The fishing experiments carried on in Ringkøbing Fiord suggest then that a considerable immigration of plaice from ca. 15—30 cm in length and of an average size of ca. 24 cm has taken place in the autumn of 1911, and a similar immigration, but on a smaller scale, must be supposed to have taken place in the autumn of 1910.

Whether such an autumn immigration of young plaice is a common phenomenon is a question which has not yet been sufficiently elucidated. By the numerous marking experiments from the Northern European countries of later years, it has become evident that the immigration tendency of the plaice in early spring goes towards the coasts, and later in spring and at the beginning of summer outwards to deeper water. Several experiments have on the other hand indicated that the migration still in autumn tends outwards (see e. g. A. C. REICHARD: »Die deutschen Versuche mit gezeichneten Schollen« II Ber. Versuch No. 58), while other experiments have pointed in the direction that the migration tendency in autumn is an inward one (see for instance A. C. JOHANSEN: Contributions to the biology of the Plaice II. Fig. 10 p. 84). We shall probably find here that the majority of the specimens which migrate outwards in autumn approach maturity, their migration being a spawning migration, while the majority of the specimens which move inwards in autumn are younger fish[1]). The investigations of MASTERMAN point in this direction. In working out the English trawl statistics for the years 1906—1909 he found that the average capture for the various months in the inshore areas A_3, B_4, and B_3 has 2 maxima: one spring and one autumn. Concerning this MASTERMAN writes as follows[2]):

»So far as small plaice are concerned, the inshore areas A_3, B_4 and B_3 show a curve which in general character has a maximum in summer and a minimum in winter. In December, January, February and March the catches are very low, falling well below 200 kilos pr. day, and probably illustrating the hibernating habits of the young plaice. This is rather confirmed by the fact that, with a slight exception in the case of C_3, the small plaice in the offshore areas do not show any marked indication of increase during winter months — if anything, a slight decrease.

But the large increase up to over 600 kilos per diem in the inshore waters is not regular. There are two pronounced maxima, in the spring and autumn, separated by a fall in midsummer.

In A_3 the maxima are about equal at 650 kilos, in the contiguous area (B_4) they are not so intense (300 and 400 kilos) and the autumn maximum is much larger than that of spring.

The secondary minimum is, in both areas, in the month of July and is greater in A_3 than in B_4. In other words, the inshore area shows more pronounced variations than its seaward neighbour. There can be little doubt that these maxima represent the well known spring and autumn inshore movements of young plaice. In each area they are reflected in lesser degree in the »medium« plaice but the category of »large« plaice shows no trace of them.

Area B_3 gives a curve of somewhat the same nature, with two maxima (spring and autumn) and a winter minimum[3]).«

Now it must be observed that the autumn maximum in the areas A_3 and B_4 might be explained in another way than by immigration. It might probably be explained only by supposing that the migration towards the deeper areas diminishes or ceases at the beginning of autumn. A greater accumulation of young plaice would then take place here in autumn than in summer. The observations which we have made in Ringkøbing Fiord point however in the direction that MASTERMAN'S explanation of the large autumn catch in A_3, B_4 and B_3 is right, at least partly, and in the same direction the circumstance points that young plaice of a length of ca. 15—32 cm seem to be remarkably more

[1]) In the Kattegat and in the Belt Sea we have noticed certain facts which suggest that many older mature fish move also towards the shores in autumn before they migrate to deeper water for the sake of spawning.

[2]) A. T. MASTERMAN: Third Report on later stages of Pleuronectidæ (p. 7—8). Rapports et Procès-verbaux des Réunions. Vol. XIV. 1912.

[3]) Similar curves with a spring and an autumn maximum are also observed in Denmark in the Areas A_2 and A_4. See A. C. JOHANSEN and E. NEERGAARD-MØLLER: Biological-statistical Report on the Produce of the Danish Sea-fishery in 1910.

frequent in the autumn months (November, December) than at other seasons in Hjerting Fiord. Only in the months of November and December, and sometimes in October and January, does the plaice occur in Hjerting Fiord so frequently that the fishery pays the fishermen. A table of the monthly capture in Hjerting Fiord in the years 1904—1912 is represented below:

Showing the yield of the Plaice Fishery in the Hjerting Fiord — kg.

	January	October	November	December
1904	—	—	125 000	135 000
1905	—	—	96 428	24 000
1906	—	—	204 165	102 085
1907	—	20 000	85 938	52 812
1908	—	—	13 333	26 665
1909	—	—	13 330	10 000
1910	—	3 335	50 000	35 000
1911	—	11 125	66 425	49 200
1912	30 000	56 000	305 000	393 000

In the remaining months not so many plaice were caught in the fiord that they are stated in the official statistics.

The relatively large captures of plaice originate in the Horns Reef area (Northern part of Area A_3 and B_4) from the period September—November, and in the Hjerting Fiord with Graadeep from the period November—December. The large captures in Ringkøbing Fiord originate in 1910 – 1911 from February and March and in 1911—1912 from November—February. The further we get into the fiords and inshore waters the later do we trace this autumn immigration.

After the opening of the Hvide Sande canal the extension of the plaice area was increased by ca. 85 nautical square miles. The question arises naturally whether this increased area also means an increase of the yield of the plaice-fishery. This question must undoubtedly be answered in the affirmative, and the increase will probably not be quite insignificant. It should here be remarked that fewer enemies of the plaice occur in the Ringkøbing Fiord than in the open waters of the North Sea, and that the two younger series grow quicker in the fiord than outside in the North Sea, (see tables 3—12 in the present treatise[1]). Among the worst enemies of the young plaice in the North Sea must be counted the dog fish (*Acanthias vulgaris*) and the cod (*Gadus callarias*). The first mentioned species occurs only very seldom in Ringkøbing Fiord, and the last is not frequent there either.

The essential importance of the fact that Ringkøbing Fiord has become a feeding place for young plaice is not to be sought in the fiord itself but in the North Sea. Only a relatively small amount will obtain a marketable size in the fiord itself. The majority will have migrated to the North Sea before they reach such a size.

How much the yield of the plaice fishery in the North Sea will increase yearly in consequence of the fact that Ringkøbing Fiord has now become a feeding ground for young plaice, cannot be calculated. Its importance as a feeding ground will evidently to an essential degree depend on the width of the Hvide Sande canal. But in general it may be said that the feeding grounds for young plaice belong to the areas which, according to their extent, contribute most to the plaice production. It is a well known fact that the greater part of the plaice fishery in the North Sea takes place in its Southern and South-eastern part, in A_2, A_3, A_4, B_2, B_3, B_4, B_5, C_2 and C_3, thus in areas which partly comprise the very feeding grounds for the young plaice and partly are situated in their immediate neighbourhood.

[1]) The great difference in the average size of the specimens of the 0-Gr. taken in the Ringkøbing Fiord and those taken at the North Sea shores off the West coast of Jutland, show that most of the young plaice come to the Ringkøbing Fiord at a very early stage, probably at the beginning of the bottom stage.

In the North Sea the yield of the plaice fishery in the years 1907—1909 in the areas A, B and C was ca. 47 000 000 kg of a value of ca. 14 500 000 Kr. on an average per year. The extent of these areas totals ca. 71 000 nautical square miles, which means a yield of 662 kg and a value of ca. 204 Kr. per square mile.

III. ON CHANGES IN THE FREQUENCY OF YOUNG PLAICE FROM ONE YEAR TO ANOTHER IN THE SHORE-BELT OFF THE WEST COAST OF JUTLAND ETC.

In a previous paper: »On the variation in frequency of young plaice in Danish waters«[1]) I have tried to show that the young plaice in different years are distributed most unequally off the coasts of Denmark and appear with very different frequency, especially when we regard one particular area.

In the Horns Reef area the 0-group of the plaice occurred in 1903 in great abundance but at the same time it was rare in the Northern Kattegat. In 1904 a more equal apportionment took place, and in 1905 and 1906 the situation was reversed.

In 1907 no investigations as to the frequency of the 0-group of the plaice were undertaken off the West coast of Jutland with the fishing-apparatus which has generally been used for the comparative fishing experiments in Danish waters, viz: the Young Plaice Trawl (see p. 4).

In 1908 no investigations with Young Plaice Trawl were undertaken off the West coast of Jutland, but the fry hatched in 1908 occurred as I-group in the fishing experiments in 1909. The chart Fig. 11 indicates that rather considerable quantities of the 0-group of the plaice came to the coasts both in the Horns Reef area, Tannis Bay and the Northern Kattegat in 1908.

In 1909 an average quantity of young plaice appeared in the Horns Reef area, while rather few were captured in the Kattegat (Fig. 7).

In the fishing experiments in 1910 this result was confirmed with respect to the Horns Reef area: Numerous specimens of the I-group occurred in Hjerting Fiord and Graadeep. In the most Northern part of the Kattegat numerous specimens of the I-group occurred likewise, but this must evidently be ascribed to an immigration of young plaice from the Skagerak. That such an immigration of specimens of ca. 1 year has taken place before, has previously been pointed out by the author by means of fin-rays investigations[2]).

In 1910 an average quantity of the 0-group of the plaice appeared both in the Horns Reef area and the Northern Kattegat (Fig. 8), but small numbers in the Southern Kattegat and in the Sound. The fishing experiments in 1911 confirmed this distribution respecting the I-group. Proportionately few specimens of the I-group occurred however in the Northern Kattegat.

In 1911 unusually small quantities of young plaice of the 0-group occurred in the Horns Reef area and off the West Coast of Jutland on the whole. In the Skagerak the 0-group was considerably more frequent, though hardly as frequent as to reach the normal standard. On the other hand an unusual number of young plaice occurred in the Kattegat, the Sound and the Belt Sea. (Fig. 9).

[1]) A. C. JOHANSEN: Contributions to the Biology of the Plaice III. 1908.

[2]) A. C. JOHANSEN: Bericht über die dänischen Untersuchungen über die Schollenfischerei und die Schollenbestand etc. 1910. On extensive migrations of young plaice see also:

H. C. REDEKE: The distribution of the plaice on the Dutch coast. Rapports et Procès-verbaux. Vol. III 1905.

Fig. 7. Plaice of the 0-Gr. captured in fine meshed Young Plaice Trawl in the fishing experiments from August 27th—October 14th 1909, calculated per hour. — August: Stations in the North Sea South of Blaavands Huk, except those where the captures have been 68, 69 and 168. — September: The stations off Fanø and Skallingen with the captures 68, 69, 168 and then from Blaavands Huk round Skagen to the Limfiord. — October: The remaining stations in the Kattegat, the Belt Sea and the Sound.

Fig. 8. Plaice of the 0-Gr. captured in fine meshed Young Plaice Trawl in the fishing experiments from 1st—25th of July and 5th—30th of October 1910, calculated per hour. — July: The stations in the North Sea, Ringkøbing Fiord included. — October: The remaining stations in the Skagerak, Kattegat and the Sound.

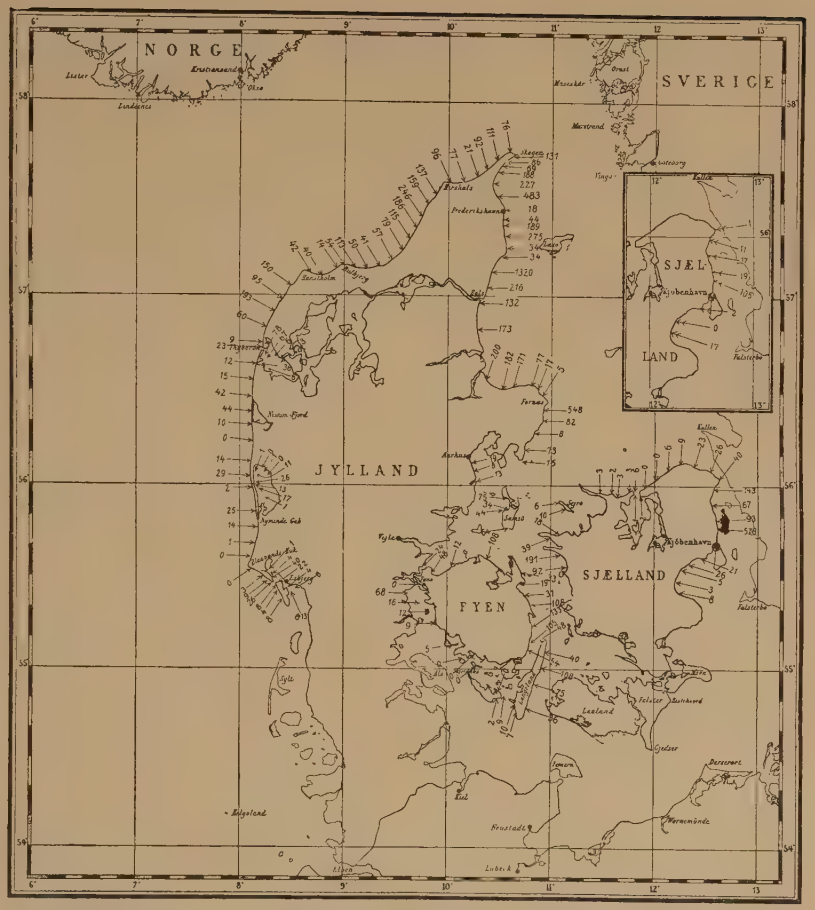

Fig. 9. Plaice of the 0-Gr. captured in fine meshed Young Plaice Trawl in the fishing experiments from July 31st—September 20th and from 2nd—11th of November 1911, calculated per hour. — July: The three stations at the West coast of Fanø. — August: All the other stations at the West coast of Jutland, Ringkøbing Fiord and Nissum Bredning included; then round Skagen down along the East coast of Jutland including the stations at Samsø, moreover the stations at the North coast of Funen down through the Little Belt, Ærø inclusive. — September: The stations at Langeland, the East coast of Funen, the West coast of Sealand, Sejrø and then stations round Sealand through the Sound. — November: The stations marked with two arrow-heads: the East side of Sealand.

Fig. 10. Plaice of the 0-Gr. captured in fine meshed Young Plaice Trawl in the fishing experiments from July 10th to October 6th 1912, calculated per hour. — July: The stations marked with two arrow-heads, 10.—17. of July: East coast and North East coast of Sealand, 29.—31. of July: Stations by Graadeep, the North Sea. — August: Stations at the West coast of Jutland with one arrow head except the two most easterly stations in the Skagerak. — September: The two most easterly stations in the Skagerak, the East coast of Jutland and the Belt Sea, Sejrø excepted, — October: Sejrø, the North and East coast of Sealand.

Fig. 11. Plaice of the I-Gr. captured in fine meshed Young Plaice Trawl in the fishing experiments from April 15th to April 30th and from August 27th to October 14th 1909. calculated per hour. — April: Stations in the Kattegat and the Belt Sea, marked with two arrow heads. — August: Stations in the North Sea South of Blaavand except those where the captures have been 6, 31, and 23. — September: The stations with the captures 6, 31 and 23 at Skallingen and Fanø, then from North of Blaavands Huk. the West coast of Jutland round Skagen to the Limfiord. — October: The remaining stations in the Kattegat, the Belt Sea and the Sound.

Fig. 12. Plaice of the I-Gr. captured in fine meshed Young Plaice Trawl in the fishing experiments from July 1st—25th and from October 5th—30th 1910, calculated per hour. — July: The stations in the North Sea, Ringkøbing Fiord included. — October: The remaining stations in the Skagerak. Kattegat and the Sound.

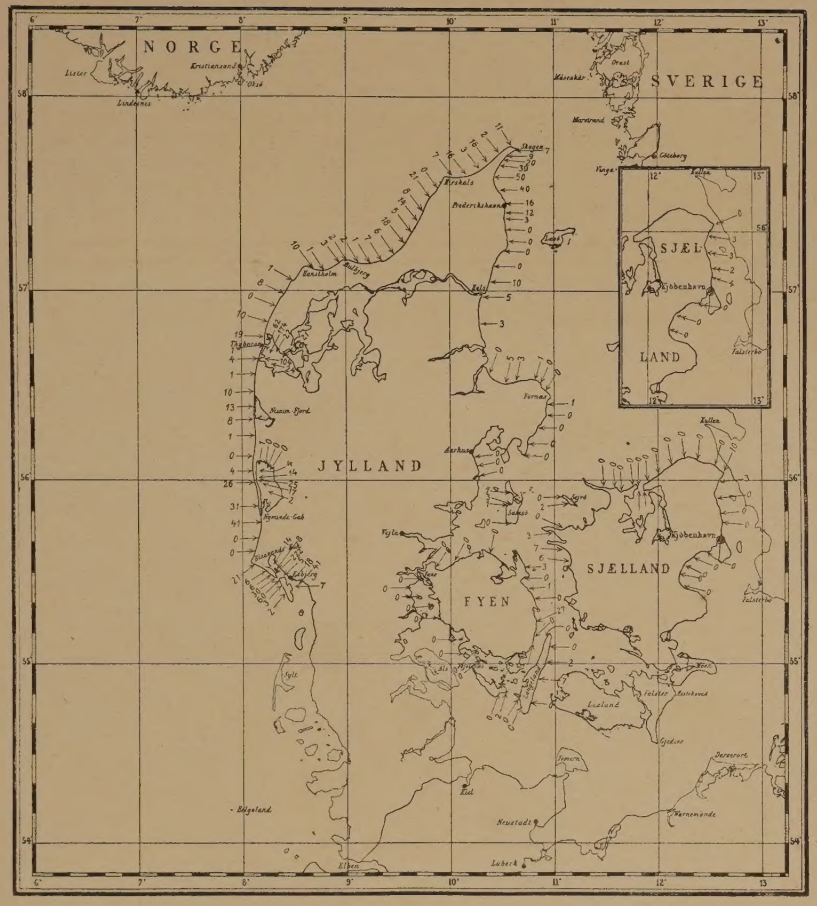

Fig. 13. Plaice of the I-Gr. captured in fine meshed Young Plaice Trawl in the fishing experiments from July 31st—September 20th and from 2nd—11th of November 1911, calculated per hour. — July: The three stations at the West coast of Fanø. — August: All the rest of the stations at the West coast of Jutland, Ringkøbing Fiord and Nissum Bredning included, then round Skagen down along the East coast of Jutland, including the stations at Samsø, moreover the stations at the North coast of Funen down through the Little Belt, Ærø inclusive. — September: The stations at Langeland, the East coast of Funen, the West coast of Sealand, Sejrø and then round Sealand through the Sound. — November: The stations marked with two arrow heads: the East side of Sealand.

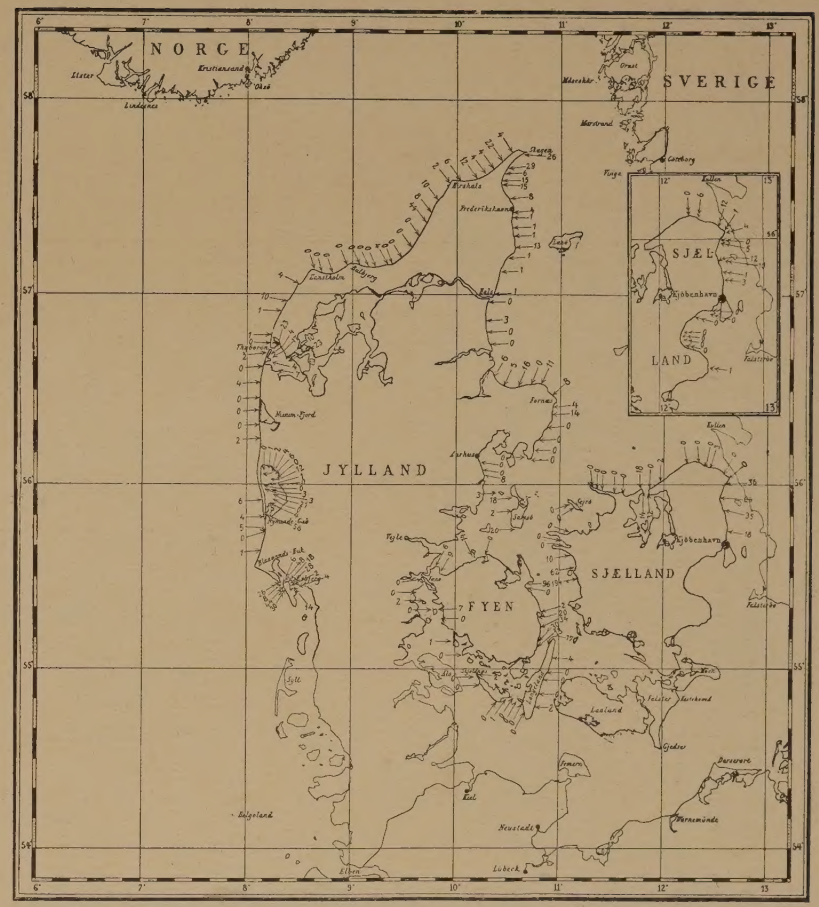

Fig. 14. Plaice of the I-Gr. captured in fine meshed Young Plaice Trawl in the fishing experiments from July 10th to October 6th 1912, calculated per hour. — July: Stations marked with two arrow heads, 10th—17th of July: East coast and North East coast of Sealand, 29—31 of July: Graadeep, North Sea. — August: Stations at the West coast of Jutland with one arrow head, except the two most easterly stations in the Skagerak. — September: The two most easterly stations in the Skagerak, the East coast of Jutland, the Belt Sea, Sejrø excepted. — October: Sejrø, the North and East coast of Sealand.

The fishing experiments in 1912 confirmed this result with regard to the North Sea. An unusually small number of the I-group occurred here (Fig. 14).

In 1912 the comparative fishing experiments were carried through to a similar extent as in the preceding year. In this year, larger quantities of the 0-group of the plaice occurred along the entire West coast of Jutland than in any of the other years from which we possess fairly extensive investigations: 1905[1]), 1909, 1910 and 1911 (Fig. 7—10). In the Southern Kattegat and in the Belts only small quantities of young plaice occurred. The distribution of the 0-group in 1912 was on the whole very similar to that in 1905, but both along the entire West coast and in the most Northern part of the Kattegat the young plaice were more numerous than in 1905.[1])

By comparing the quantity of young plaice captured per hour in the North Sea and the Skagerak with the numbers captured in the Kattegat and Belt Sea it should be remembered that the captures in the first named waters have mostly taken place in July, August and September, and in the latter ones mostly in September, October and November. — In September and especially in October and November very many plaice of the 0-group move out to greater depths than those where the fishing experiments with the Young Plaice Trawl have taken place (from ca. 0.7—3 meters, depth), and thus the captures in those months become much smaller than in July and August. How great the difference is, appears on the charts Fig. 9 and Fig. 10, which among other things illustrate captures at different seasons but at the same places in the Sound.

[1]) See A. C. Johansen: Contributions to the Biology of the Plaice III 1908. By comparisons as to the frequency of the 0-group in different years, it should be remembered that the fishing-apparatus employed in 1905 and 1906 was somewhat smaller than that employed in the years 1907—1912. The length of the foot rope was in 1905—1906 c. 5 meters, in all later years 7 meters. The figures from 1905 and 1906 should be multiplied by c. 1.5 to be comparable with the figures from the rest of the years.